

# Body Size, Sex Ratio and Reproduction of *Bandicota bengalensis* in Northern Punjab, Pakistan

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**Abstract.**— A 1 year study was made of body size, sex ratio and reproduction of *Bandicota bengalensis* from a cropland area near Islamabad, Pakistan. A total of 367 rats was captured, consisting of 171 males (46.6%) and 196 females (53.4%). The sex ratio did not differ significantly from a 50:50 ratio. Body weight and head and body length of males were significantly greater than of females. Body weight in males continued to increase with age. The breeding season extended from April to September with no breeding in June. The annual rate of pregnancy was 25.3%. Mean number of embryos per female was  $10.6 \pm 0.5$ . Annual production of young was 36 per female.

**Key words:** Bandicoot, rodent pest, reproduction, northern Punjab, Pakistan.

## INTRODUCTION

The lesser bandicoot rat, *Bandicota bengalensis*, is widely distributed as a number of races in southern and southeastern Asia. In Pakistan, there are two separate populations of bandicoot rat, one ranges over central and northern Punjab, and in the southern part of North-Western Frontier Province (NWFP), and the other one is confined to Sindh (Roberts, 1977; Smiet *et al.*, 1978). The bandicoot rat is the principal pest of agricultural crops in Sindh, NWFP and Punjab. Information on the ecology, abundance and reproduction of the bandicoot rat of lower Sindh has been documented by Fulk *et al.* (1981a), of central Punjab, by Beg *et al.* (1981), Khan and Beg (1984), Khokhar (1986) and Rana (1989). Our knowledge about the segment of the bandicoot rat population inhabiting northern Punjab is fragmentary. This study presents information about the body size, sex ratio and reproduction in bandicoot rat inhabiting agricultural crops near Islamabad.

## STUDY AREA

Lesser bandicoot rats were trapped from crop fields of the National Agricultural Research Centre (NARC), Islamabad. NARC spreads over an area of about 600 ha. This site (33° 42'N, 73° 07'E) lies near the northwestern limits of the range of the bandicoot rat in south and southeastern Asia (Roberts, 1977).

The records of environmental factors for this study

period were obtained from Meteorological Observatory, NARC. Temperatures varied from 1.7°C in January to a mean maximum of 38°C in June. Both mean maximum and minimum fell steadily during first 7 months, then rose during the next 5 months. Rainfall was recorded in all months except November, with highest in July (71.8 cm) and very little in April (0.6 cm) and May (0.7 cm). Day length was shortest (10 h) in December and longest (14 h 25 m) in June.

## MATERIALS AND METHODS

Rats were trapped during each month from July, 1988 through June, 1989. They were captured in gopher-type traps set inside the mouths of burrows and with wire-mesh live traps (14x14x14 cm) which were baited with fresh potato, onion and chapatti (roti). Areas trapped were wheat fields and fallow wheat fields following harvest. A few animals were trapped from groundnut and rice fields and from grassy areas.

Captured animals were brought to the laboratory and killed with chloroform. They were sexed, weighed and measured before being necropsied. The following information was recorded from the female rats: vaginal orifice open or closed, condition of uterus (nulliparous, pregnant, placental scars), condition of ovaries (corpora lutea visible or not), number of embryos and crown-rump length. For male rats: the position of the testes (abdominal or scrotal), length, width and weight of the testes and whether the tubules were visible or not in the cauda epididymus.

The 50% points in body weight (BW) and head and body length (HBL) at which females showed visible corpora lutea and males showed visible tubules in the cauda epididymis were calculated following Davis (1964). All animals equal to or exceeding these values

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were defined as adults, while all others were considered as immature. The rate of reproduction was calculated as the number of young produced per female per year following Southwick (1966).

## RESULTS

### *Characteristics of the sample*

A total of 367 rats, 171 males and 196 females, was examined. The characteristics of the sample in terms of HBL, BW of the two sexes are given in Table I. The two sexes did not differ ( $P > 0.05$ ) in their mean BW at equivalent HBL up to the 199 mm HBL class. However, above this point, males became significantly ( $P < 0.05$ ) heavier. Males predominated in numbers in the largest HBL classes. The largest male weighed 431.0 g and had 245 mm HBL. The heaviest female weighed 350 g and had HBL of 220 mm, the largest female had HBL of 232 mm. The mean BW of males ( $n=171$ ) was significantly ( $P < 0.01$ ) higher than those of the females ( $n=153$ , non-pregnant). The mean HBL of males was also significantly ( $P < 0.05$ ) longer than that of the females.

A positive relationship existed between HBL and BW for both the sexes. The HBL and BW of the males ( $r = 0.901$ ;  $df = 169$ ;  $P < 0.001$ ) and HBL and BW of non-pregnant females ( $r = 0.911$ ;  $df = 151$ ;  $P < 0.001$ ) were significantly correlated. The proportion of males to females was 46.6:53.4, which did not differ significantly from a 50:50 ratio ( $X^2 = 0.46$ ,  $P > 0.05$ ).

### *Reproduction*

According to 50% points for sexual maturity criteria in BW and HBL, all males having BW of  $\geq 160$  g or HBL  $\geq 178$  mm were classified as adults and all females having BW  $\geq 98$  g or HBL  $\geq 158$  mm were considered as adults. All other animals were classified as immatures.

Males with scrotal testes were found in almost all the BW classes (Table II). Majority (53.1%) of subadult males ( $< 160$  g) had scrotal testes. Conversely, some large animals ( $> 300$  g) had abdominal testes. There was an increase in testes volume with increase in BW but this increase was not consistent. Adjusted testes weight and volume in males having BW  $> 160$  g were significantly higher ( $P < 0.05$ ) than those of the males having BW  $< 160$  g.

Breeding activity in females was examined by BW and HBL (Table III). Pregnancy first appeared in the 170-179 mm HBL size class but became significant in females having HBL  $\geq 180$  mm. Maximum proportion

of pregnant females (75%) was observed in the 210-219 mm HBL class. The smallest pregnant female weighed 129.1 g.

Forty three of the 170 adult females (25.3%) were visibly pregnant. The females in the 120-159 g BW range had very low breeding activity. Breeding activity increased as the females attained 200 g of BW.

The prevalence of pregnancy, adjusted for all adult females (98 g BW or 158 mm HBL), is given in Table IV. The two periods of female reproductive activity were in April-May and July-September. These two periods of pregnancy in females were separated by reproductive inactivity from October through March. During the summer month of June, no pregnant females were recorded. The annual pregnancy rate was 25.5%. The pregnancy rate in the spring sample (April-May) was more (67%) than in the summer-fall sample (30%). The April sample gave the highest (81.5%) prevalence of pregnancy.

Data on parity in bandicoot females are summarized in Table V. Primi-gravid females constituted 76% of all pregnancies. The 1:0.26 ratio between primi- and multi-gravid females suggested that, on average, a female that became pregnant for the first time would have a 26% chance of living long enough to have second pregnancy.

Litter size was obtained by noting the number of grossly visible uterine swellings or embryos. In general, the number of embryos decreased as pregnancy progressed. Early pregnancies showed a mean of 11.1 embryos/female, while the mean embryo count in the last term of pregnancy was 9.1, a decrease of two embryos, or 18% embryo loss. The unadjusted litter size was  $10.6 \pm 0.5$ . There was no noticeable pattern in mean litter size examined monthly (Table IV). Further it was observed that litter size increased with increasing HBL of the female ( $r = 0.323$ ;  $df = 42$ ;  $P < 0.05$ ). A similar correlation ( $r = 0.317$ ;  $df = 42$ ;  $P < 0.05$ ) was found for BW of females and litter size.

## DISCUSSION

In this study we defined sexually mature females having  $\geq 98$  g BW or  $\geq 158$  mm HBL and sexually mature males having  $\geq 160$  g BW or  $\geq 178$  mm HBL. These observations are not in agreement with figures given by Khan and Beg (1984), Chakraborty (1977), Rana (1989). But these parameters are close to 114 g of BW and 150-160 mm HBL as measured by Kausar (1981) in central Punjab, Pakistan. Fulk *et al.* (1981), in lower Sindh, found that the smallest pregnant female

Table I.- Head and body length (HBL) and body weight (BW) of *Bandicota bengalensis* (Mean  $\pm$  S.E.). Only non-pregnant females were used for computation of body weight.

HBL Classes (mm)	Males		Females		P<0.05	
	n	BW (g)	n			BW (g)
			Total	Non-Preg.		
> 140	3	49.9±16.4	12	12	62.5±2.5	N.S
140-149	5	93.4±5.2	10	10	80.0±3.6	N.S
150-159	11	104.9±3.1	12	12	103.9±6.0	N.S
160-169	15	123.2±5.2	17	17	116.5±6.5	N.S
170-179	18	151.2±5.6	20	17	154.0±5.5	N.S
180-189	31	179.3±4.9	28	19	175.1±5.5	N.S
190-199	32	215.8±5.6	46	34	209.1±5.4	N.S
200-209	25	236.6±7.1	35	25	215.2±6.8	0.05
210-219	20	278.2±9.0	12	3	256.4±10.2	N.S
220-229	8	294.8±22.6	2	2	313.0±37.0	N.S
230 >	3	388.6±27.4	2	2	288.9±14.6	0.05
Totals	171		196	153		
Mean BW		198.3±5.5			178.7±4.8	0.01
Mean HBL		188.1±1.7			183.2±1.7	0.05

Table II.- Changes in testes position, adjusted testes weight/100 g body weight and testes volume with the body weight (BW) classes.

BW Classes (mm)	n	Testes Position				Testes weight g/100 g BW (Mean±S.E.)	Testes volume (ml) (Mean±S.E.)
		Abdominal		Scrotal			
		No.	%	No.	%		
80-99	12	6	50.0	6	50.0	0.27±0.03	0.15±0.02
100-119	12	7	58.3	5	41.7	0.23±0.04	0.17±0.02
120-139	10	5	50.0	5	50.0	0.22±0.03	0.26±0.04
140-159	15	4	33.3	10	66.7	0.22±0.03	0.27±0.05
160-179	22	10	45.5	12	54.5	0.31±0.03	0.47±0.06
180-199	25	10	40.0	15	60.0	0.36±0.03	0.64±0.07
200-219	9	5	55.6	4	44.4	0.43±0.04	0.92±0.12
220-239	18	11	61.1	7	38.9	0.35±0.03	0.78±0.08
240-259	12	5	41.7	7	58.3	0.38±0.05	0.93±0.13
260-279	9	3	33.3	6	67.7	0.36±0.03	0.95±0.07
280-299	8	3	37.5	5	62.5	0.31±0.03	0.70±0.10
300-319	9	0	00.0	9	100.0	0.37±0.03	1.07±0.11
320-339	3	1	33.3	2	66.7	0.28±0.06	1.05±0.18
340 >	5	1	20.0	4	80.0	0.28±0.02	1.14±0.06

Table III.- Relationship of head and body length (HBL) and body weight (BW) to visible pregnancy in female *Bandicota bengalensis*.

HBL Classes (mm)	No.	Pregnant		BW Classes (g)	No.	Pregnant	
		No.	%			No.	%
<170	52	0	0.0	<120	45	0	0.0
170-179	17	3	17.6	120-139	8	1	12.5
180-189	28	9	32.1	140-159	15	1	6.7
190-199	46	12	26.1	160-179	24	7	29.2
200-209	35	10	28.6	180-199	30	3	10.0
210-219	12	9	75.0	200-219	22	7	31.8
220-229	2	0	0.0	220-239	17	6	35.3
230-239	2	0	0.0	240-259	13	7	53.8
-	-	-	-	260-279	13	5	38.5
-	-	-	-	280-299	3	2	66.7
-	-	-	-	300>	6	4	66.7

Table IV.- Reproductive pattern of adult female *Bandicota bengalensis* by month.

Month	No. observed (adult females)	No. visibly pregnant	Prevalence of pregnancy (%)	Embryo/female (X±SE)
July	6	2	33.3	10.0±1.0
August	28	12	42.9	9.3±1.1
September	20	2	10.0	10.5±1.5
October	22	-	-	-
November	16	-	-	-
December	13	-	-	-
January	7	-	-	-
February	8	-	-	-
March	7	-	-	-
April	27	22	81.5	11.7±0.7
May	13	5	38.5	9.4±1.2
June	6	-	-	-
Total/avg.	170	43	25.3	10.6±0.5

Table V.- Parity in *Bandicota bengalensis* based on head and body length (HBL).

HBL classes (mm)	n	Nulli-parous (n)	Parous			
			Primi-gravid (n)	Multi-gravid (n)	Non-gravid with scars	
					1-Set	2-Set
120-129	3	3	-	-	-	-
130-139	9	9	-	-	-	-
140-149	10	10	-	-	-	-
150-159	12	12	-	-	-	-
160-169	17	15	-	-	2	-
170-179	20	8	2	1	7	2
180-189	28	7	8	1	11	1
190-199	46	1	8	4	23	10
200-209	35	4	8	2	18	3
210-219	12	0	8	1	1	2
220>	4	0	0	0	3	1
Totals	196	69	34	9	65	19

weighed 89 g and that generally the females were first impregnated between 90-109 g BW. The weight at which males became sexually mature was generally between 70 to 159 g.

The males tended to be significantly heavier and longer than females. Kaur and Guraya (1983) also reported that males were heavier than females. A gradual increase in BW with the increase in HBL was

seen. A non-significant difference in the BW of both sexes at equivalent HBL classes (upto 199 mm HBL) indicates that the sexes grow at approximately the same rate during the early growth stages. Sagar and Bindra (1978) also observed that in the initial 5 months, growth of males and females was similar. Heavier males in the higher HBL classes indicated that growth of males continued until old age. This observation is supported

by Sagar and Bindra (1978) who found that BW in males continued to increase for the 9 months of age.

The sex ratio did not differ significantly from equality. Although other trapping studies (Spillett, 1968; Chakraborty, 1977; Khan and Beg, 1984; Rana, 1989) have indicated an excess of males which might have been due to the larger home ranges of males, giving them increased trappability (Burt, 1940; Davis, 1953; Fulk *et al.*, 1981b). But that was not the case here because most of the animals were captured directly from burrows via gopher traps. The present findings on sex ratio are in agreement with those of Kaur and Guraya (1983).

The prevalence of pregnancy was related to body size of the female. The prevalence increased considerably as the females attained 200 g BW and 180 mm HBL. The positive correlation between female HBL and embryonic litter size indicated that the productivity of female bandicoot rat increased with age and increasing body size.

The mean litter size (unadjusted to allow for embryo loss) of 10.6 is the highest reported for this species (Spillett, 1968; Walton *et al.*, 1978; Sagar and Bindra, 1978; Smiet *et al.*, 1980; Fulk *et al.*, 1981a; Beg *et al.*, 1981; Kaur and Guraya, 1983; Khan and Beg, 1984; Rana, 1989). Only the mean of 10.3/female, reported by Khokhar (1986) from rice and wheat fields in Punjab, matches the figure observed in the present population.

The breeding season of the bandicoot rat observed here extended from April to September, with a gap during this period in June. These two periods of breeding activity were separated by a long period of reproductive inactivity from October to March. Field populations of bandicoot rat in lower Sindh were found to breed almost year round (Smiet *et al.*, 1980 and Fulk *et al.*, 1981a). However, the northern population of the bandicoot in Indian Punjab did not breed in January, February and September (Sagar and Bindra, 1978). Khan and Beg (1984) found that field-living bandicoots in central Punjab, Pakistan did not breed from November through February. Kaur and Guraya (1983) found two peaks in breeding activity, spring and late summer, with a decline in June in Ludhiana, Indian Punjab. Rana (1989) also found no pregnant females during the winter months in central Punjab, Pakistan. Because the range of the lesser bandicoot rat in Asia approaches its northern and western limits near Islamabad, perhaps the effects of climate, especially day length and winter temperatures, have a strong influence upon the breeding of what is essentially an Oriental species of rodent.

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